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Transportation demand management: a park and ride system to reduce congestion in Palembang city Indonesia

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Abstract

Park and Ride is one of Transport Demand Management (TDM) scheme, which is very popular in some congested city with wide parking area at the border line or outskirt area. Palembang is capital city of South Sumatera Province, which has three Terminals in the border area with surrounding kabupaten (district). Right now the Terminal is not functioned appropriately because many public transport vehicles are loading and unloading passengers outside the Terminal, or on the street nearby the Terminal. On the other hand, the city centre itself has been crowded of private vehicles (car and motor cycle). The current on street parking system has been no longer adequate. According to Cities Development Initiatives for Asia (CDIA) study 2011, about 1382 cars and 1431 motorcycles need a place to park in the city centre. The aims of this paper are to present the characteristics of trips surrounding the Terminal and to know their potential of accepting Park and Ride system, and to plan the program and policy regarding Park and Ride in Palembang. The Data was collected by doing Home Interview survey in Palembang, with 4000 sample of Households (Buchari, 2011). Method of Analysis is descriptive Analysis, Cross tabulation, matrices analysis and multimodal analysis. The data from previous study was used to analyze the interconnection Terminal location with trips from surrounding areas. The results showed the potential shifting from private vehicle user to park and ride user.

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Keywords: Park and Ride system; Transport Management Demand; Home Interview Survey

1. Introduction

Palembang is the capital city of South Sumatera with the area of 369,22 km^2 consisting of 16 subdistricts

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(kecamatan), namely Kecamatan Alang-Alang Lebar, Kecamatan Bukit Kecil, Kecamatan Gandus, Kecamatan Ilir Barat I, Kecamatan Ilir Barat II, Kecamatan Ilir Timur I, Kecamatan Ilir Timur II, Kecamatan Kalidoni, Kecamatan Kemuning, Kecamatan Kertapati, Kecamatan Plaju, Kecamatan sako, Kecamatan Seberang Ulu I, Kecamatan Seberang Ulu II, Kecamatan Sematang Borang, and Kecamatan Sukarami. The city is also divided by Musi river into two parts, namely Ulu (upstream) part and Ilir (downstream) part.

Public Transport vehicles in Palembang consist of Oplets with 8 to 9 passengers seats and buses with 20 to 21 seats (29 including standing facilities). The number of Oplets seem to be excessive because they are left by their passengers and shifted to Ojek or other public transport modes. Like many cities in developing countries, Palembang also has congestion problems and exccessive number of motorcycles. Some measures have been done to overcome congestion problems, but the problems remain. It is inevitable that Palembang have sustainable transport, such as Multimodal Public Transport (MMPT). Multimodal Public Transport (MMPT) is defined as a trip that consists of two or more transport modes which are combined and interconnected with a transfer point (Bovy 2002). By combining and integrating the public transport modes, it is expected that the travel time would be shortened. However, the multimodality of travel and the factors determining the Share of Multimodal Travel have not been discovered yet.

Park and Ride, according to Collin English Dictionary, is a transport system which is designed to encourage drivers to park their cars some distance away from a city centre, tourist attraction, etc, and complete their journey by public transport. It is one of Transport Demand management scheme, which is very popular in some congested city with wide parking area at the border line or outskirt area. Palembang has three Terminals in the border area with surrounding kabupaten (district) as it is explained in Fig. 1.

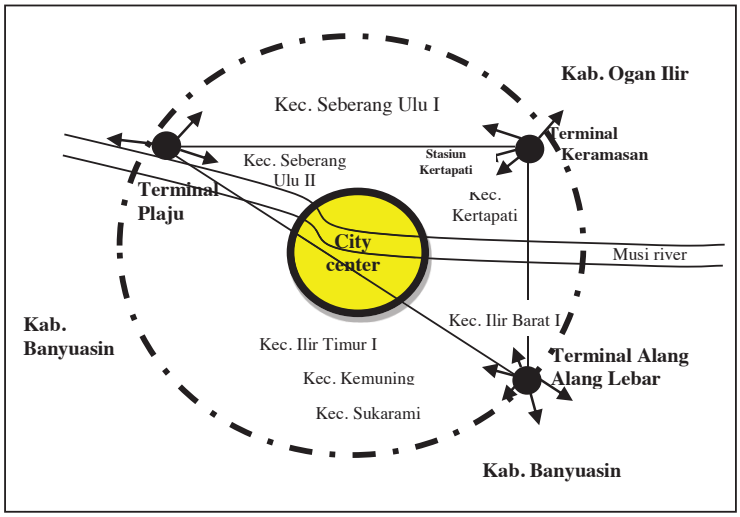


Fig 1: Sketch of Study Area

Right now the Terminal is not functioned properly because many public transport vehicles load and unload passengers outside the Terminal, or on the street nearby the Terminal. On the other hand, the city centre itself has been crowded of private vehicles (car and motor cycle). The current on street parking system has been no longer adequate. According to the study of Cities Development Initiatives for Asia in 2011, 1382 cars and 1431 motorcycles need a place to park in the city centre.

1.1. Problem Formulation

The problem formulated in this paper is:

1. How is the characteristics of trips around the Terminal and ?
2. How is the potential of accepting Park and Ride system?
3. How to make the program and policy regarding Park and Ride in Palembang?

1.2. The Aim of Paper

The aims of this paper are:
1. To present the characteristics of trips around the Terminal.
2. To know the potential of accepting Park and Ride system.
3. To show the program and policy regarding Park and Ride in Palembang.

2. Literature Study

In order to detect the potential people who can be persuaded to change their travel habit or travel modes the six componens of multimodality are adopted. Six element of multimodal public transport [2] consist of (1) Connecting Modes (2) Main Modes (3) Multimoda Public Transport Network (4) Tranfer Point (5) Intermodal Transfer Point and (6) Counter Measures (Regulation and Policy) Park and Ride in multimodality.

Inherently multimodal transport already exists, but what are the characteristics of multimodal mobility today in developing countries? In what extent multimodality can affect the TDM measures such as Park and Ride? Buchari E (2008, 2010, 2011) has proven the Cross tabulation method of trips can be used to detect the need of Transfer Point and Intermodal Transfer Points. Cross Tabulation of Matrix Origin1-Mode 1, are used to measure the demand for potential users of Park and Ride, car and motorcycle users. This theoretical justification of method turns up after the method itself has been used empirically for Palembang (2004 data, Bogor and Depok 2009 data). Policy and Implementation of Parking Ride System has been aplied successfully between 1970s to 1990s in many countries such as France, Calgary, Canada, Scotland, Malaysia and Hongkong.

3. Methodology

Interview Survey was conducted on 12th to 18th September 2011, at the residential area in 16 districts Zones (kecamatan), as it is coded and can be seen in table 1. This survey was aimed to identify the passenger travel pattern in Palembang and other trip characteristics. The survey tool used questionaires to capture the trip characteristics, which were needed for analysis of Park and Ride system. 4000 samples are taken in stratified sample which were distributed proportionally to all districs (kecamatan) in Palembang. Parameters measured were the characteristics of respondents and their capacity in making trips. Those parameter were family size, status, gender, age, *income*, *job status*, car *ownership*, motorcycle *ownership*, and priority using vehicles.

Table 1: Zone Coding of Study Area, Palembang

Zone	Zone Code
Kecamatan Bukit Kecil (Kelurahantalang Semut, 22 Ilir, 19 Ilir, 23 Ilir, 26 Ilir, 24 Ilir)	1
Kecamatan Gandus (Pulo Kerto, Kel. Gandus, Kel. Karang Anyar, Kel. 36 Ilir, Kel. Karang Jaya)	2
Ilir Barat 1 (Kelurahan 26 Ilir I, Lorok Pakjo, Demang Lebar Daun, Bukit Baru, Siring Agung)	3
Ilir Barat 2 (Kelurahan 35 Ilir, 32 Ilir, 30 Ilir, Kemang Manis, 29 Ilir, 28 Ilir, 27 Ilir)	4
Kecamatan Ilir Timur 1 (13 Ilir, 14 Ilir, 15 Ilir, 16 Ilir, 17 Ilir, 18 Ilir, 20 Ilir I, 20 Ilir III, 20 Ilir IV, Kepandean Baru, Sei Pangeran)	5
Ilir Timur 2 (10 Ilir, 11 Ilir, Kuto Baru, Lawang Kidul, 3 Ilir, 1 Ilir, Sungai Buah, 2 Ilir, 5 Ilir, Duku, 9 Ilir, 8 Ilir)	6
Kalidoni (Bukit Sangkal, Kalidoni, Sei Selayur, Sei Selincah, Sei Lais.)	7
Kecamatan Kemuning (Sekip Jaya, Pahlawan, 20 Ilir2, Pipa Reja, Talang Aman, Ario Kemuning)	8
Kecamatan Kertapati	9
Kecamatan Plaju	10
Sako (Kelurahan Sako, Sukamaju, Lebung Gajah, Sialang, Srimulyo, Suka Mulya)	11
Seberang Ulu 1	12
Seberang Ulu 2	13
Sukarame (Kelurahan Sukajaya, Srijaya, Sukarami, Alang-Alang Lebar, Talang Betutu, Sukabangun, Kebun Bunga,Talang	14

Zone	Zone Code
Kelapa, Karya Baru)	
Indralaya	15
Pangkalan Balai	16
Mariana	17
Indralaya	18

4. Results and Discussion

4.1. Trip Characteristics

Trip characteristics are analysed by SPSS program, and the results are shown in the following table 2.

Table 2: The characteristics of travel pattern of respondents in Palembang.

Variables	Characteristics
Family status	Father 31.73%; Children 33.53%; Mother 26.98%; Relatives 4.8%; Grand father/Grand mother 2.98%
Family Size	Less than 2 people in family 6%; 3 people 14%; 4 people 26%; 5 people 26%; 6 people 15%; 7 people 7%; 8 people 3%; more than 8 people 3%
Sex	Men (54,70%); Women (45.30%)
Age of Trip Makers	Age 15-18 (13,10%); Age 18-25 (20.43%); Age 25-55 (60.50%);; Age 55-65 (4.68%); Age >65 (1,30%)
Job Status	Professional 1%; Manager 0.40%; PNS/Government Official 13.15%; Trader/retailers 17.65%; Farmer 0.70%; Driver 2.08%; Labour 7.50%; Security 13.15%; Students 25.05%; Housewife 12.90%; Unemployment 1.38%; Others 16.05%
Car Ownership	No car 66.30%; One Car 27.73%; Two Cars 4.75%; Three Cars 0.93%; More than 3 cars 0,30%
Motorcycle Ownership	No Motorcycle 2.4%; One 42.56%; Two 31.81%; Three 7.33%
Priority Using Car	No priority 85%; With priority 15%
Priority Using Motorcycle	No priority 48%; With priority 52%
Frequency of using cars per week	Once perweek 1.58%; Twice 1.80%; three times 1.95%; four times 1.05%; five times 2.20%; six times 2.00%; seven times 19.48%; never 69.95%
Frequency of using motorcycles per week	Never 22.50%; Once perweek 1.27%; Twice 2.30%; three times 0.0%; four times 1.13%; five times 2.73%; six times 6.55%; seven times 60.88%; More than 7 times 0.13%
Transfer Points	Station 0.80%; Halte (Bus stop) 4.32%; Parking Area 1.90%; On Street 92.98%
The reason for not riding a bus	Not safe 16.63%; Not economical 13.80%; Long time 18.45%; Difficult access 27.78% Not safe and long time 12.10%; Not safe, not economical and long time 4.67%, Others 7.08%
The reason for not riding an oplet (non formal public transport)	Not safe 16.63%; Not economical 19.30%; Long time 31.53%; Difficult access 15.65% Not safe and long time 3.78%; Not safe, not economical and long time 1.42%, Others 3.40%

4.2. Analysis of Multimodality

Results of Interview Survey in Palembang showed multimodality as presented in the following table 3. There is a dicrease in multimodality and increase in motorcycle use in Palembang, from32,94% in year 2004 becomes 21,67% in year 2011.

High multimodality for bus (75,26 %) and Oplet (58,14%) showed their dependencies to other modes. These dependencies were captured by Ojek, Becak, and other modes. While, private vehicle users like motorcycles and cars, have very little combination to other modes. It can be seen from the lowest multimodality as 4.46% for motorcycles

and 1.65% for cars. This value must be regarded as performance indicator for increasing potentials of Park and Ride, which number should be increased continuously.

Table 3: Level of Multimodality of Passenger Trips in Palembang

Modes of Transportation	All modes	Unimode	Multimodes	Multimodality Percentage
Walking	16,47%	9,59%	6,88%	41,77%
Modes of Transportation	All modes	Unimode	Multimodes	Multimodality Percentage
Bicycle	2,67%	2,60%	0,07%	2,62%
Boat	0,56%	0,39%	0,17%	30,36%
Becak	4,01%	2,66%	1,35%	33,67%
Private motorcycle	43,09%	41,17%	1,92%	4,46%
Ojek (motorcycle taxi)	7,03%	5,43%	1,60%	22,76%
Bus passenger	6,71%	1,66%	5,05%	75,26%
Oplet passenger	6,02%	2,52%	3,50%	58,14%
Taxi passenger	0,03%	0,01%	0,02%	66,67%
Private Car	10,92%	10,74%	0,18%	1,65%
Car passenger	1,66%	1,41%	0,25%	15,06%
Trruck passenger	0,04%	0,00%	0,04%	100,00%
Train and Others	0,79%	0,15%	0,64%	81,01%
TOTAL	100%	78,33%	21,67%	

Sources: Data Analysis, 2011

4.3. Developing Park and Ride

Analysis of Six Components of Multimodal Public Transport can be used to develop Park and Ride as the following;

1) Analysis of Connecting Modes

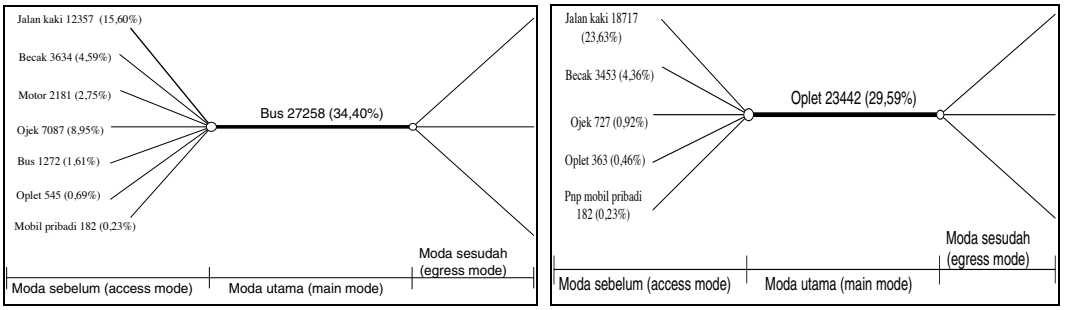
For connecting modes, Matrix Origin1-Mode1 can be analyzed to derive demand for Park and Ride. Several areas surrounding those three Teminals (Plaju, Keramasan, and Alang Alang Lebar) are discussed in the following sub sub sections.

a) Kecamatan Gandus, the demands are 6360 motorcycle users (0,88% of Palembang population) and 4907 car users (0,68%).
b) Kecamatan Ilir Barat 1, the demands are 23988 motorcycle users (3,30% of Palembang population) and 4907 car users (0,68%).
c) Kecamatan Ilir Barat 2, the demands are 7996 motorcycle users (1,10% of Palembang population) and 1090 car users (0,15%).
d) Kecamatan Ilir Timur 1, the demands are 10903 motorcycle users (1,50% of Palembang population) and 4180 car users (0,58%).
e) Kecamatan Kemuning, the demands are 25986 motorcycle users (3,57% of Palembang population) and 10903 car users (1,50%)
f) Kecamatan Kertapati, the demands are 49611 motorcycle users (6,83% of Palembang population) and 5270 car users (0,73%).
g) Kecamatan Plaju, the demands are 5270 motorcycle users (0,73%).
h) Kecamatan Seberang Ulu 1, the demands are 28712 motorcycle users (3,95%) and 545 private car users (0,07%)
i) Kecamatan Seberang Ulu 2, the demands are 72508 motorcycle users (9,98%) and 14720 car users (2,03%)
j) Kecamatan Sukarami, the demands are 13993 motorcycle users (1,93%) and 1999 car users (0,28%).
k) Kecamatan Alang-Alang Lebar, the demands are 15083 motorcycle users (2,07%) and 7087 car users (0,97%).

2) Moda Utama (*Main Mode*)
The main modes are detected from analysing matrix Moda 1-Mode2, and it reveals that the most used modes are the second modes, which are considered as main modes. The main mode is overlapped on its functions between buses and oplets, which shows Bus users 26456 (34,17%) and oplet users 22727 (29,34%).

3) Multimoda Public Transport Network
Road Network Analysis was done by using Matrix Origin and Mode (Origin1-Mode1). Then, from the matrix, it can be recognized which one is play a role as main network and which one is feeder. From this research, it can be identified that main network is overlapped between Bus (34,40%) and Oplet (29,59%). Actually, classification of roads should be followed by hyrarchical network services. By promoting Park and Ride, multimodal public transport network should be readjusted too, because potential riders would change their modes to buses as it has longer journey time than oplet. Oplet services should be distributed to access and egress modes only.

4) Transfer Point (TP)
Transfer Point analysis was done by analysing matrix Mode1-Mode2. This mode combinations were used by respondents in doing their activities. Trip makers who used one mode only (walking, bicycle, motorcycle, car, taxi, boats) were not considered, they are as many as 647,663 people perday. People's trip with combination were 79213 trips, they are presented in the following figure.



(a) (b)

Fig 2(a). Combination of access and Buses main modes in Palembang (b) Combination of access and Oplets main modes in Palembang

5) Intermodal Transfer Point (ITP)
Intermodal Transfer Point analysis was done by analyzing matrix Mode1-Mode2 as for transfer points. This mode combination of Mode1-Mode2 were used by respondents in doing their activities in different services, such as road and river, road and train . There are 49611 motorcycle users (6,83% of Palembang population) and 5270 car users (0,73%) in Kecamatan Kertapati, who are potentials to combine their trips with train and road public transport. Kertapati, trains station, firstly should have safe parking.

6) Counter Mesure (regulation, Organization and Policy)
A number of Counter Mesure (regulation, Organization and Policy) has to be set up in order to support the Park and Ride system, such as (a) Multimodal Transfer Point regulation, (b) Organisation as provider, (c) Payment system, (d) partnership system, (e) Regulation for tendering the Parking and Ride service, (f) Organisation as supervisor of the Park and Ride system in daily basis, such as Transport Authority.

4.4. Monitoring Program

In order to maintain the continuity of the program, monitoring program should be set up. Performance indicator is a tool to maintain the program, therefore main performance indicator from the survey result is presented in tabel 4 and targeted program for monitoring park and ride system is presented in table 5.

Table 4: Performance Indicator of Monitoring Park and Ride

No	Indicator	2011 (Base line)	2016 targeted
1	travel times private vehicle to work	21 min	25
2	Km-motorcycle travelled	2,883,394	2,240,000
3	Km-car travelled	352.415	300.000

Table 5: Targeted Program for Monitoring Park and Ride system

Target Performance	Performance Indicators	Target
Reduce motor vehicle users per capita	Private car 2011: 352.415 (vehicle-km)	• Year 2011: 352,415 veh-km • Year 2016: 300,000 veh-km
	Private motorcycle year 2011: 2,883,394 veh-km	• Year 2011: 2,883,394 veh-km • Year 2016: 2,240,000 veh-km
Increase transit efficiency	Increase transit efficiency (passenger-km per vehicle-km), tahun 2011: 375,498 passenger transit km.	Effciency in year 2012: 500,000/35,000 = 14,29
	Transit efficiency: 375.498 pass.km divided by veh.km = 12.02	Year 2016: 750,000/40,000 = 18,75

5. Conclusion

From the previous analysis and discussion, it can be concluded as the following:

1) The characteristics of trips of people around the Terminal are with no car 66.30%; one car 27.73%; two cars 4.75%; three cars 0.93%; more than 3 cars 0,30%; no motorcycle 2.4%; one motorcycle 42.56%; two motorcycles 31.81%; three motorcycles 7.33%. no priority of cars 85%; with priority of cars 15%; no priority of motorcycle 48%; and with priority of motorcycles 52%.
2) The potential of accepting Park and Ride system are obtained from (a) creating the regulation of the utilization the transfer point (TP) in order to attract currently majority of on street Transfer Point (92.98%). (b) taking opportunity of rejecting public transport as opportunity to give more bus services to public by giving easy access to buses in Terminal and Transfer Point, safest place in Terminal and no queueing vehicles in Terminal (such as: respondents can not use buses because buses are not safe 16.63%; not economical 13.80%; long time journey 18.45%; difficult access 27.78%; not safe and long time journey 12.10%; not safe, not economical and long time journey 4.67%, others 7.08%).
3) The program and policy regarding Park and Ride in Palembang is to reduce motor vehicle users per capita and increase transit efficiency. In order to maintain the continuity of the program, monitoring program should be set up. Performance indicator is a tool to maintain the program, therefore main performance indicator from the survey result and targeted program for monitoring park and ride system is very essential.

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